BULLETIN OF
THE NEW YORK ACADEMY
OF MEDICINE

VOL. 55, NO. 8 SEPTEMBER 1979

FRACTURES OF THE ORBITAL FLOOR

HOWARD W. SMITH, M.D., D.M.D.

Associate Clinical Professor of Otolaryngology
Yale University School of Medicine

Section of Otolaryngology, Department of Surgery
Hospital of St. Raphael
New Haven, Connecticut

FRACTURES of the floor of the orbit may occur from trauma to the orbital area from various directions. An understanding of the location, construction, and composition of the vulnerable portion of the floor of the orbit is essential to correct diagnosis and proper treatment of orbital floor injuries.

ANATOMY

The orbital cavity is a somewhat lopsided cone approaching a pyramidal shape with its tip pointing backward, upward, and medially. The floor inclines upward as it extends posteriorly and inclines laterally throughout, being higher medially. Most of the orbital floor concerned in this discussion is composed of very thin maxillary bone comprising the roof of the maxillary sinus (Figure 1). The inferior orbital vessels and nerves pass in a parasaggital plane from back to front in the substance of this thin bone through the inferior orbital canal, which is slightly lateral to the midline of

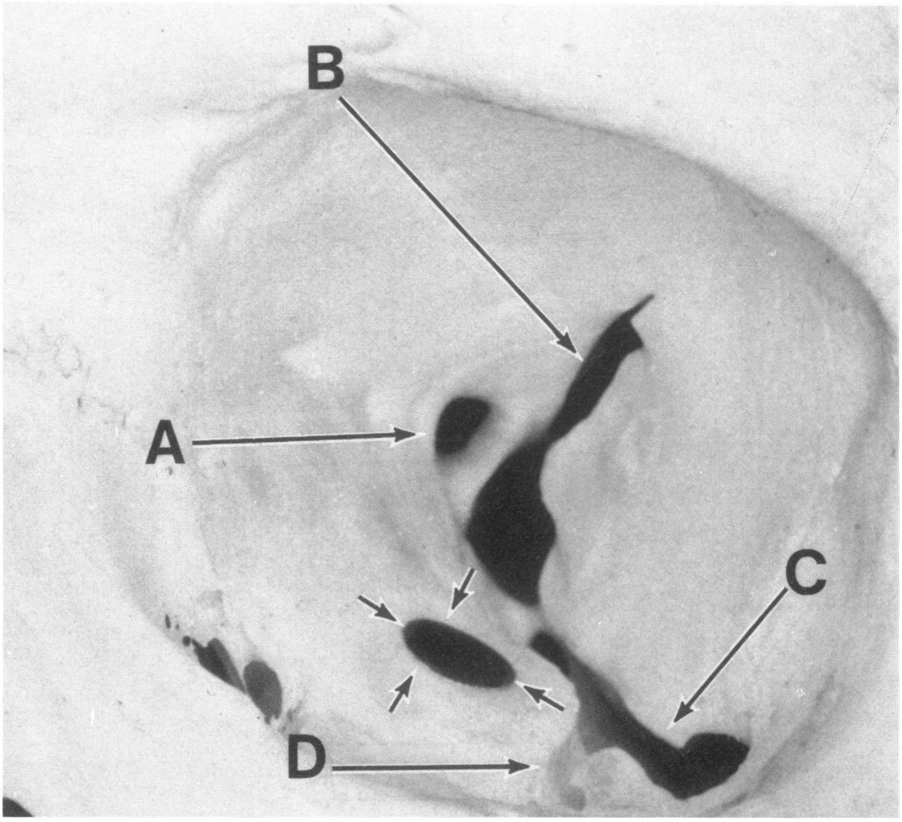

Fig. 1. Photograph of left orbit. A. optic foramen; B. superior orbital fissure; C. inferior orbital fissure; D. open superior portion of inferior orbital canal. (Arrows indicate the area of the thin orbital floor.)

the orbital floor. This canal may be deficient posterosuperiorly. Inferiorly and laterally the zygoma provides a thin shelf of bone to complete the anterior orbital floor (Figure 2). Anteriorly, the orbital floor is lower than the inferior orbital rim. The zygomatic bone provides the lateral one half of the inferior orbital rim, the maxillary bone provides the medial portion of the orbital rim and a small contribution along its most medial extent from the lacrimal bone.

INJURY

Fractures of the floor of the orbit may occur as a single injury from increased intraorbital pressure with outward collapse of one or more adjacent paranasal sinus party walls.[1-4] Collapse may allow a portion of the

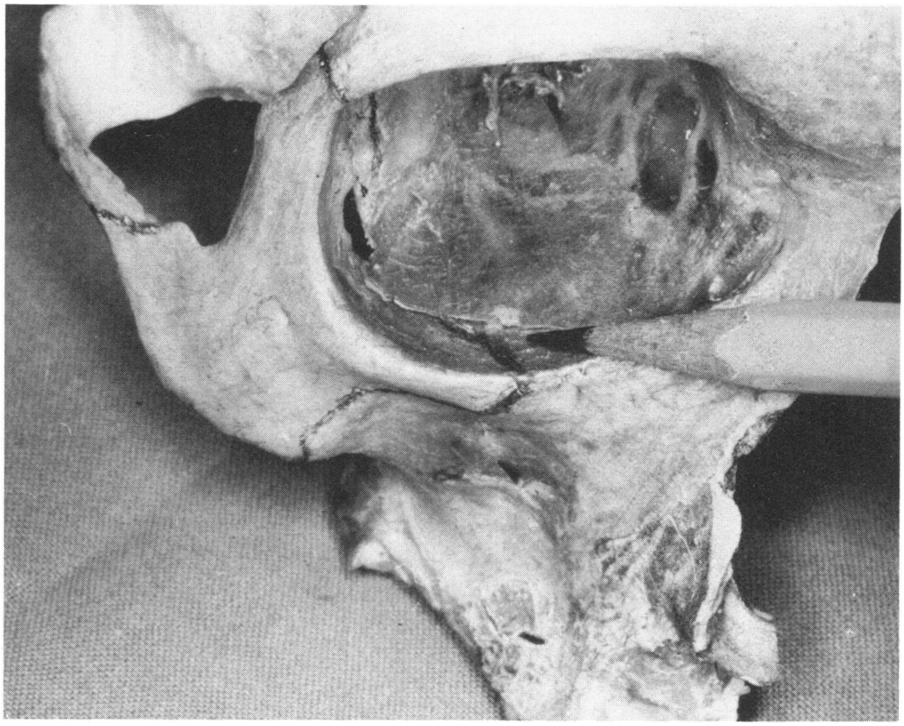

Fig. 2. Photograph of right orbit. Note anterior-lateral floor of orbit composed of zygomatic bone.

orbital contents to be forced through the rupture including orbital fat, orbital musculature, and even the eye globe itself (Figure 3). The severity of the injury may vary from a simple "black eye" to an empty orbital cavity. Fractures of the facial skeleton frequently extend into and often completely destroy the osseous orbital floor. These fractures are often associated with overlying soft tissue injury and require detailed clinical and radiographic study prior to treatment. In injuries marked by severe facial skeletal dislocation, the orbital floor must be carefully assessed at the time of reduction and fixation of the mid-facial skeleton.

Role of the Ophthalmologist and Otolaryngologist

The ophthalmologist and otolaryngologist share a common interest in orbital floor fractures. When the orbital contents extrude into the paranasal sinuses, the otolaryngologist is concerned. When the sinus walls collapse into the orbit, the ophthalmologist is concerned. In addition to this, the

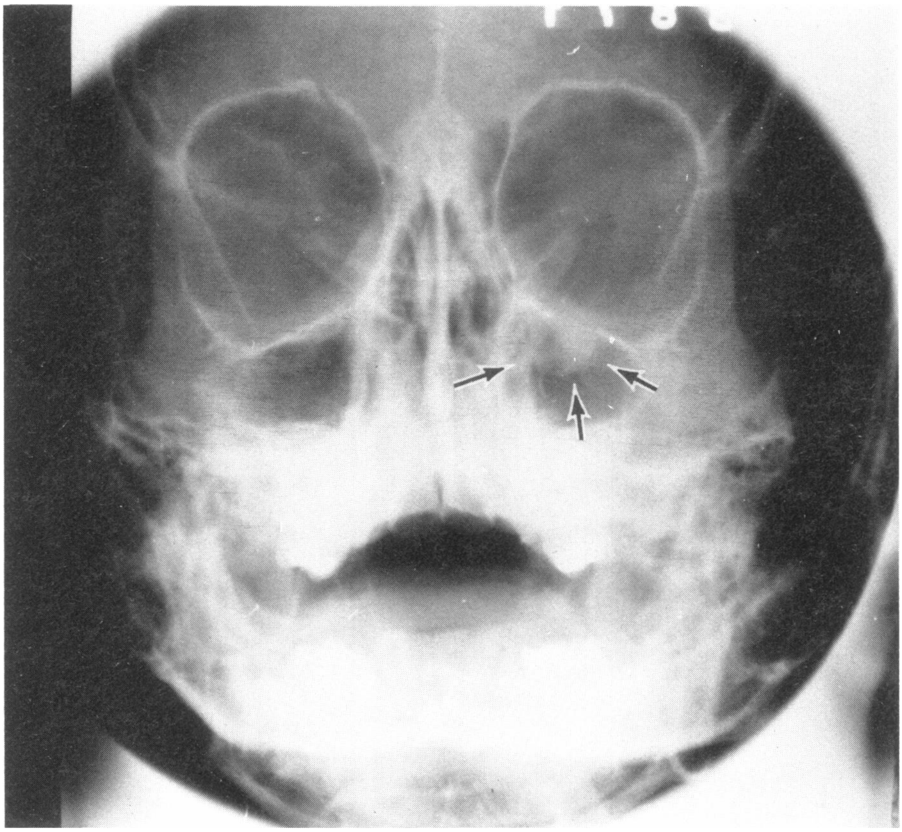

Fig. 3. Maxillary sinus roentgenogram, Waters view. Blow-out fracture of left orbital floor (arrows).

ophthalmologist is concerned when the location and function of the dislocated eyeball causes visual disturbances. The ophthalmologist is exceptionally qualified to assess both normal and abnormal positions of the eyeball in the bony orbit and the functional capacity of muscles attached to the eyeball which may undergo any of the following: muscle contusion and hematoma; muscle severance; muscle trapping; muscle detachment from either its site of origin or site of insertion; and dislocation of the site of origin or site of insertion of the muscle causing a change in the length or direction of its action, thereby producing assessable visual disturbances.

In addition to dislocation of the eyeball itself, the "simple" black eye must be thoroughly evaluated for the following additional concerns: injury to the cornea; injury to the retina; dislocation of the lens; and orbital hematoma.

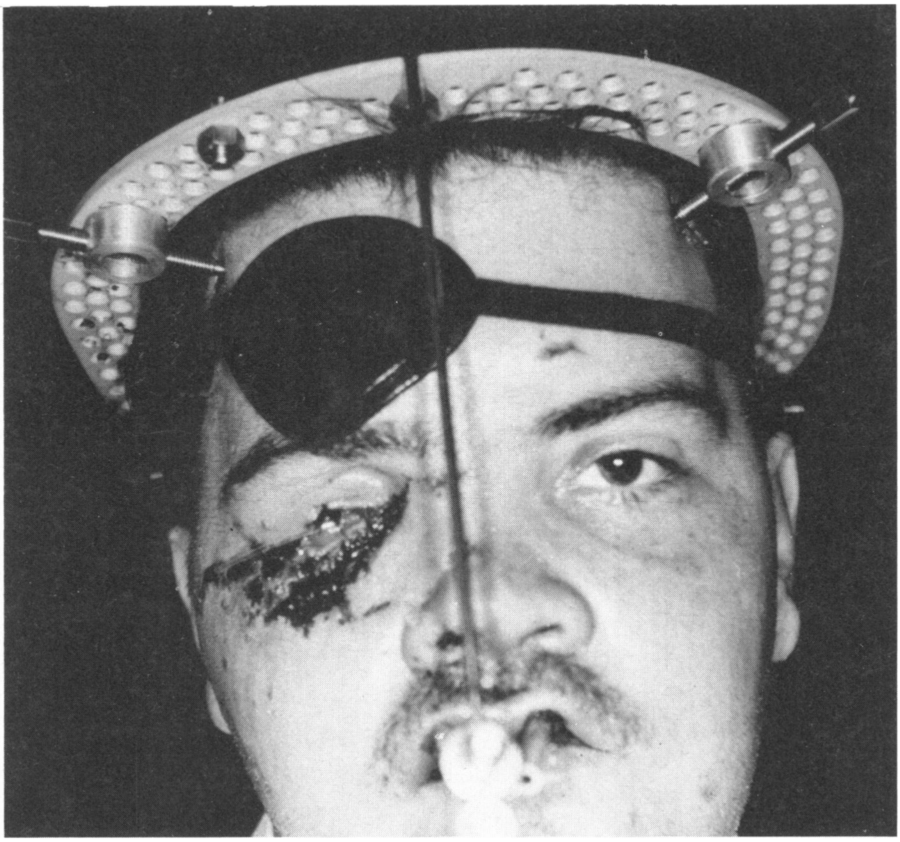

Fig. 4. Photograph of patient with multiple facial fractures and crushed right eye globe with loss of vision.

These concerns may not be sufficiently impressive because soft tissue edema rapidly occludes the patient's vision. Because of inability to open the eye, visual disturbances are not appreciated by the patient until the swelling recedes, which may be several days later. The more extensively injured individual may be unconscious and responses necessary to provide vital visual information are lost. In the absence of patient response, the ophthalmologist can best analyze the condition of the eye. Great contributions are available from the ophthalmologist in the diagnosis and treatment of lacrimal injuries, corneal injuries, retinal and lens injuries, and the correct positioning of the eye with respect to the bony orbital cavity.

The otolaryngologist should be acutely aware of possible eye injury when treating midfacial, skeletal, and soft tissue injuries even in the absence of overt orbital trauma. Fortunately for the otolaryngologist, lacrimal injuries are not present in a high percentage of patients with midfacial trauma. Repositioning the nasal ethmoid complex, the inferior orbital rim and the zygomatic bone often correct occular muscle imbalance and restore the suspensory ligaments to a normal position for support of the eyeball. There remains, however, the orbital floor (roof of the maxillary sinus), which deserves serious attention. In most midfacial trauma, LeFort II and LeFort III, it is necessary to provide support for the orbital muscles and to consider separation of these muscles from both soft tissue and bony fragments which may subsequently produce scarring and muscle inactivity. If the eyeball is severely injured and loss of the eye seems certain (Figure 4), it may be advisable to replace the destroyed orbital floor prior to enucleation so that there will be support for a prosthesis.

Otolaryngological History

The otolaryngologist should make every effort to obtain a history of the injury from the patient and from observers of the injury. The nature of the object, its direction, and its speed may be of interest, especially when minimal trauma is visible on the surface. If the patient is able to respond, the quality of vision immediately after the accident and before development of swelling should be assessed. Symptoms of diplopia or impaired visual acuity may be rapidly obscured by ecchymosis and edema. Bleeding from the nose, numbness of the face, disturbed dentition, and inability to open and close the mouth should all be assessed.

Otolaryngologic Examination

One should assess gross vision, look at the cornea, retina, and scan the range of motion of the orbital muscles. The conjunctiva should be examined, the lids and orbital rim carefully palpated, comparing the injured side with the normal side. In the presence of extensive ecchymosis and edema, persistent digital pressure over an anticipated fracture site, especially along the inferior orbital rim, will often squeeze out the edema so that a step or separation can be appreciated. One can anticipate an orbital floor fracture of some magnitude in all zygomatic fracture dislocations, some fronto-ethmoid crushing injuries, most LeFort II and perhaps all LeFort III fractures. A fracture of the floor of the orbit should be considered to be present in each instance until proved otherwise.

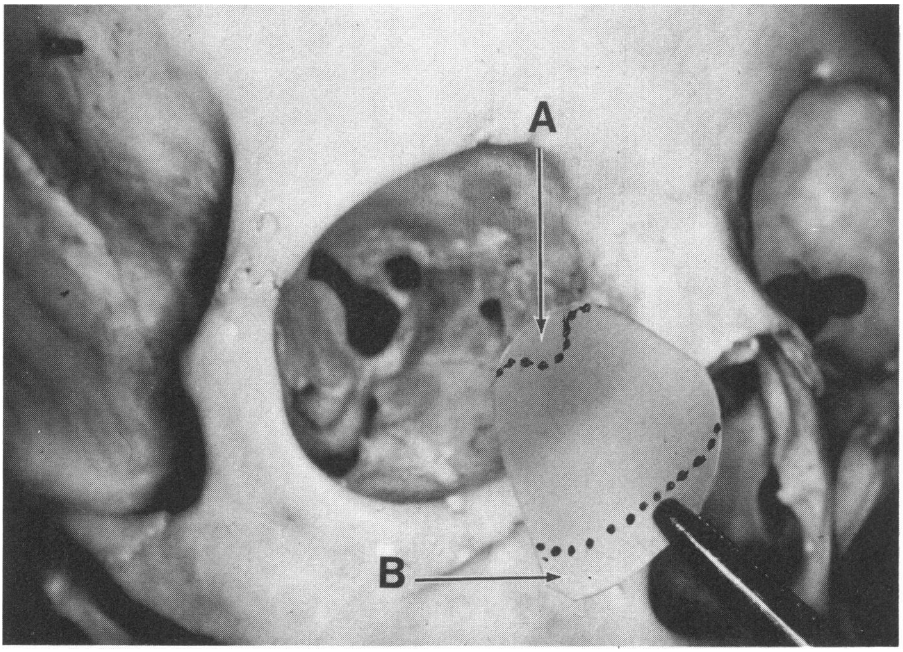

Fig. 5. Photograph of right orbit. Demonstrating preparation of sialastic sheet for orbital floor implant. A; cut out posteriorly for inferior rectus muscle; B. cut off anteriorly to fit behind inferior orbital rim.

Roentgenograms

Radiologic analysis of facial fractures and especially orbital floor fractures is extremely helpful. Armed with the knowledge of the injury and the physical examination findings, one can consult intelligently with the radiologist and provide him with information vital to a perceptive radiologic examination. A face full of ecchymosis and edema, with sinuses full of blood, when combined with facial skeletal displacement makes the radiologists' contribution a difficult one. Often the patient is too ill to be positioned for all of the standard radiographic views, and specialized procedures cannot be undertaken. In those instances, the Waters view is the single most helpful roentgenographic film (Figure 3).

Mechanics of Repair

Occasionally, the diagnosis of an orbital floor fracture can only be made at surgery. This is true when facial swelling, ecchymosis, and bleeding make it impossible clinically to evaluate eye-muscle movement and poor

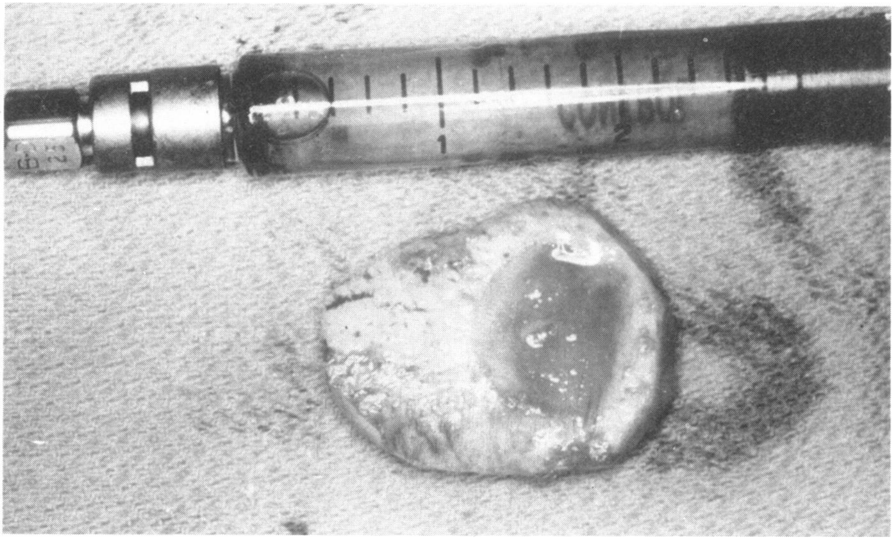

Fig. 6A.

Fig. 6B.

Fig. 6. Photograph of rib graft preparation and insertion for correction of enophthalmos. A. preparation of rib graft to restore left orbital floor; B. insertion of graft; C. seating of graft behind inferior orbital rim; D. photograph of after-insertion of graft showing elevation of left eye globe.

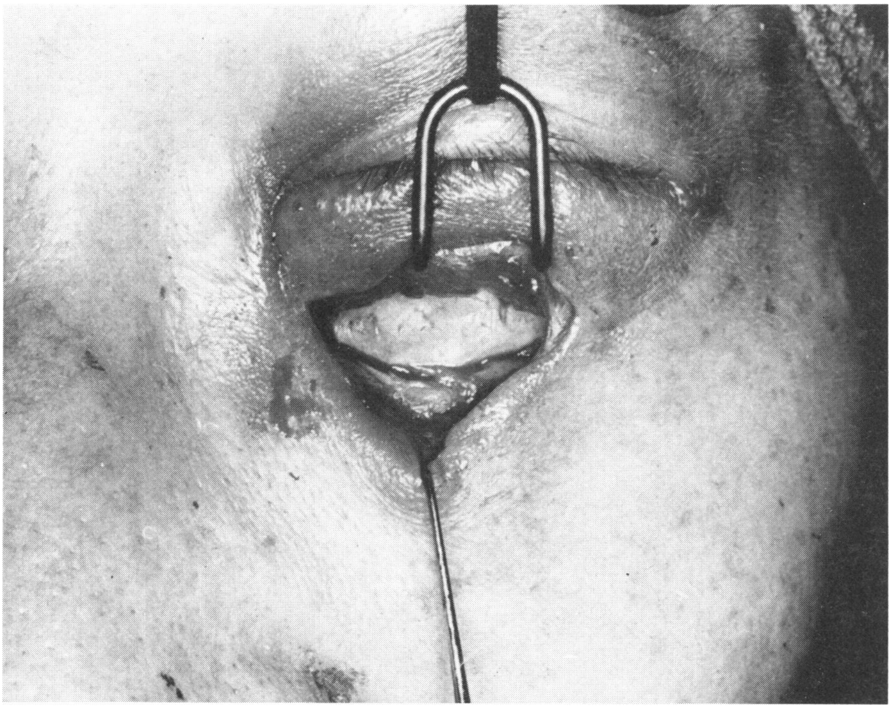

Fig. 6C.

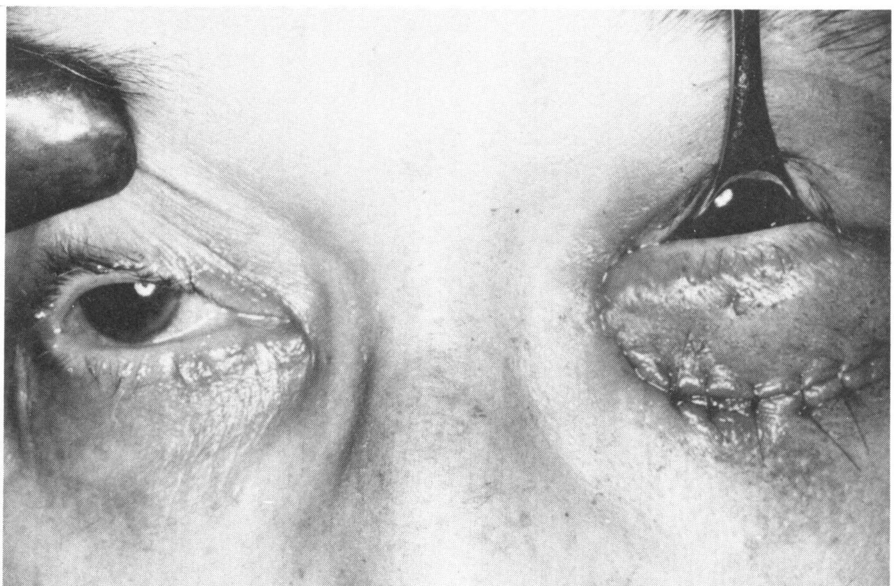

Fig. 6D.

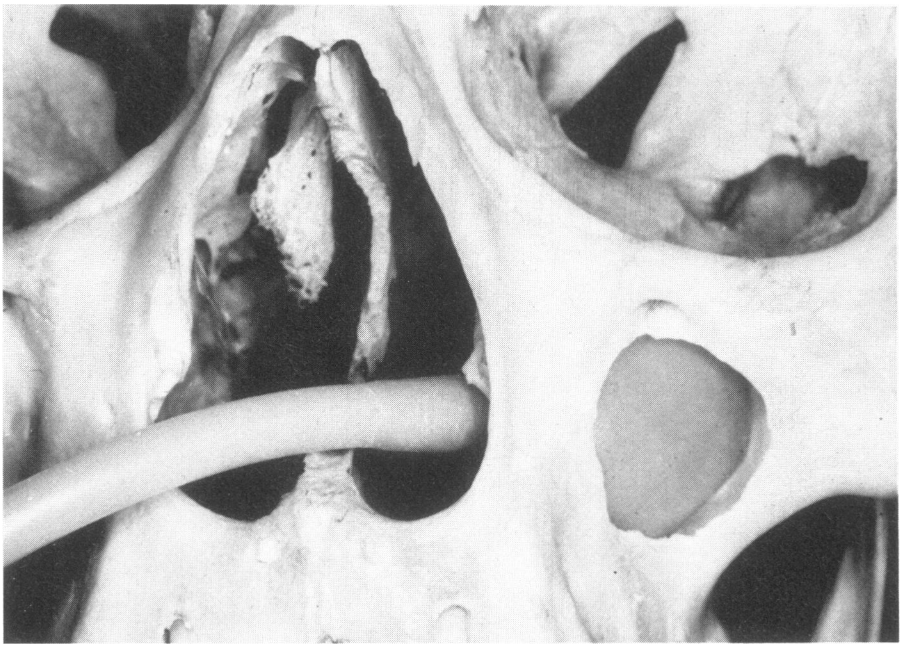

Fig. 7. Photograph of skull demonstrating use of antral balloon to elevate fractured orbital floor.

contrast roentgenograms cannot demonstrate disruption of the very thin orbital floor. The most popular approach to repair seems to be direct exploration of the orbital floor through an inferior orbital rim incision. The exposure may be made through an incision directly over the infraorbital rim or through the lower eyelid. Most of the floor of the orbit can be observed under direct vision through this approach. Muscle entrapment can be relieved and material placed over the defect such as sialastic (Figure 5), septal cartilage, thin anterior maxillary sinus bone, metal mesh, etc. In long-standing injuries with enophthalmos and a lowered eye globe, a large piece of rib bone (Figure 6, A,B,C,D), rib cartilage or bone from the iliac crest may be used to raise the level of the eyeball. Some surgeons prefer to work through the maxillary sinus and prop up the floor of the orbit with antral packing or with an antral balloon (Figure 7).

Observations and Considerations

1) A contused orbital muscle may simulate a blow-out fracture of the orbital floor. Delayed diplopia, absence of a fracture which can be dem-

onstrated by roentgenograms and an equivocal muscle traction test may be caused by muscle contusion or hematoma within the muscle.

2) Sialastic sheeting (Figure 5) should be notched posteriorly to accommodate the inferior rectus muscle to prevent hindrance to muscle movement.

3) Sialastic sheeting should be made short enough to lie comfortably behind the inferior orbital rim on the floor of the orbit anteriorly. Proper length of the prosthesis and closure of the orbital fascia at the rim margin should prevent extrusion of the sialastic implant.

4) In most severe facial skeletal trauma, bone is lost from crushing at the areas of articulation. Even though the dislocated facial bones are placed in their correct position and fixed with wiring, this loss of bone structure, which may exceed 0.5 cm. at the suture lines, may subsequently cause drifting and secondary defect formation.

5) Enophthalmos may not be correctable, even in the hands of knowledgeable and skillful surgeons despite what appears to be an adequate therapeutic program.

6) When roentgenograms are obtained in the posterior anterior projection, the thin orbital floor is taken in its cross-section and not along its longitudinal dimension. Multiple angulations of the Waters view may be helpful by aligning the fragment with the central beam of x rays to produce enough bone substance for evaluation of its position. These multiple Waters views at varying angles are most helpful in the absence of tomographic or contrast radiologic studies.

7) Trivial skin markings secondary to injury deserve adequate workup for vision, especially when ecchymosis and edema and other circumstances prevent the patient from assessing his own vision.

REFERENCES

1. Mackenzie, W.: *Traité Pratique des Maladies des Yeux*. Paris, Trad. Laugier et Richelot, 1844.
2. Lang, W.: Dislocation of the trochlea. *Trans. Ophthalmol. Soc. U. K. 9*:41, 1889.
3. Pfeiffer, R. L.: Traumatic enophthalmos. *Arch. Ophthalmol. 30:*718-28, 1943.
4. Smith, B. and Regan, W. F., Jr.: Blowout fracture of orbit: Mechanism and correction of internal orbital fracture. *Am. J. Ophthalmol. 44*:733-39, 1957.